Kaon Update

New WCTrack reconstruction algorithm, aerogel cut and TPC calorimetry cut for the study of Kaons in LArIAT

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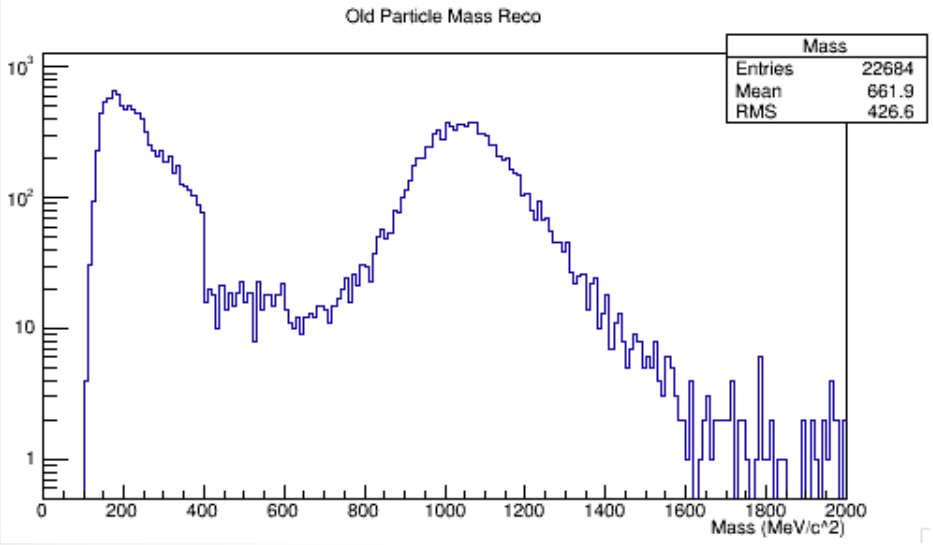
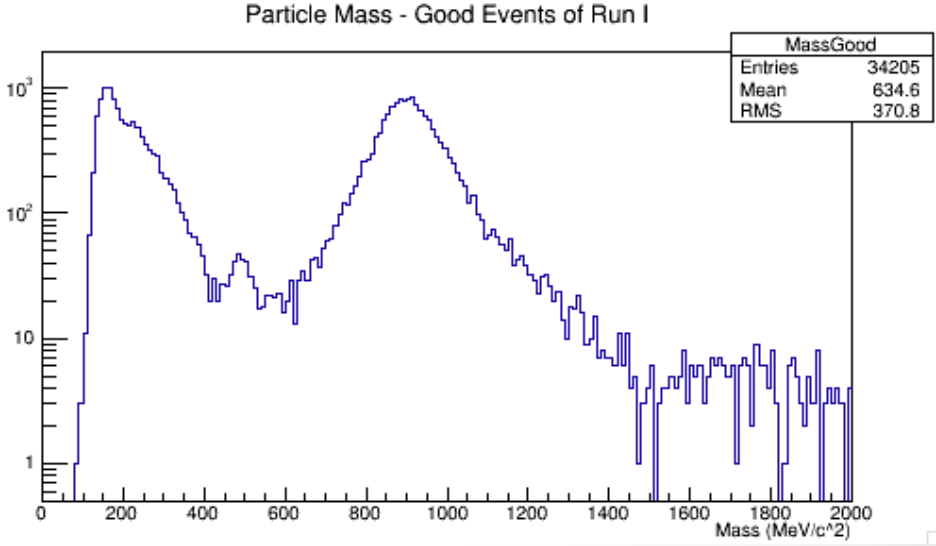
WCTrack Reco

Greg Pulliman developed a new WCTrack reco. algorithm
~50% increase in events with WCTracks
Allows events with only three coincident WC hits

Before:

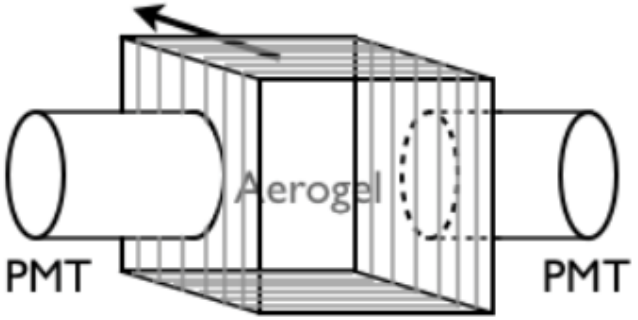


After:



Fit on peak: 483 +/- 44 MeV/c^2

Aerogel Cut



From looking at events, there is heavy pion and proton contamination. Aerogel can be used to tag and remove pions from the kaon sample

A particle produces Cherenkov radiation after a threshold energy and momentum defined by:

$$E = \frac{m}{\sqrt{1-\left(1/n\right)^2}} \qquad p = \sqrt{E^2 - m^2}$$

In LArIAT, the Aerogel have refraction indices of n = 1.05 and 1.10, leading to a momentum thresholds of:

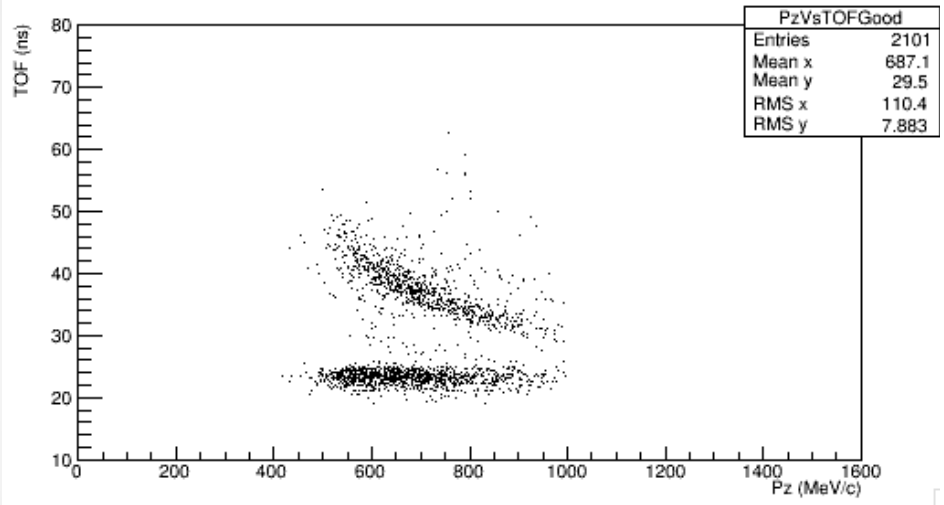
	Pi+ (MeV/c)	K+ (MeV/c)	Proton (MeV/c)
n = 1.05	437	1555	3000
n = 1.10	306	1087	2046

Range 306 to 1087 MeV/c encompasses all of the kaon sample from Run I

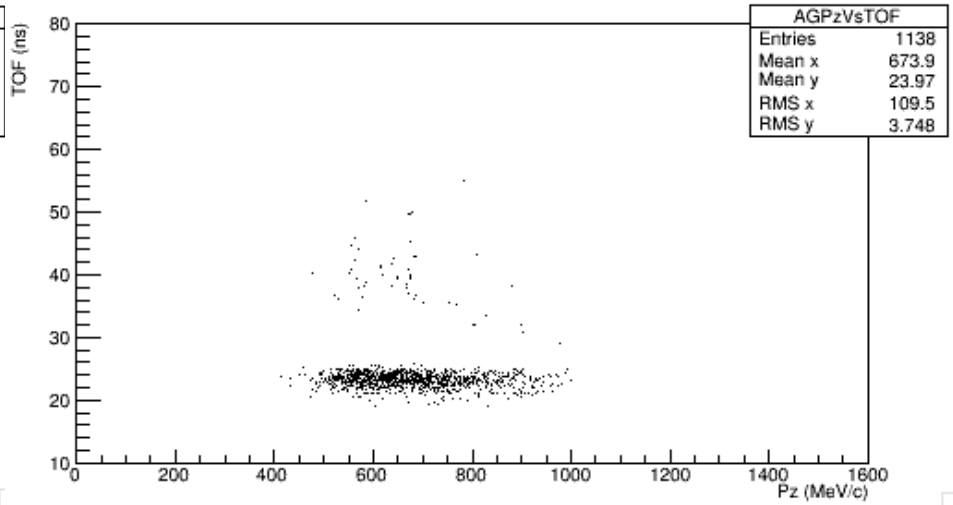
Aerogel Cut - Efficiency

Run 6259 with a cut on Pz at 1000 MeV/c

All Events



Events with A.G. Hits



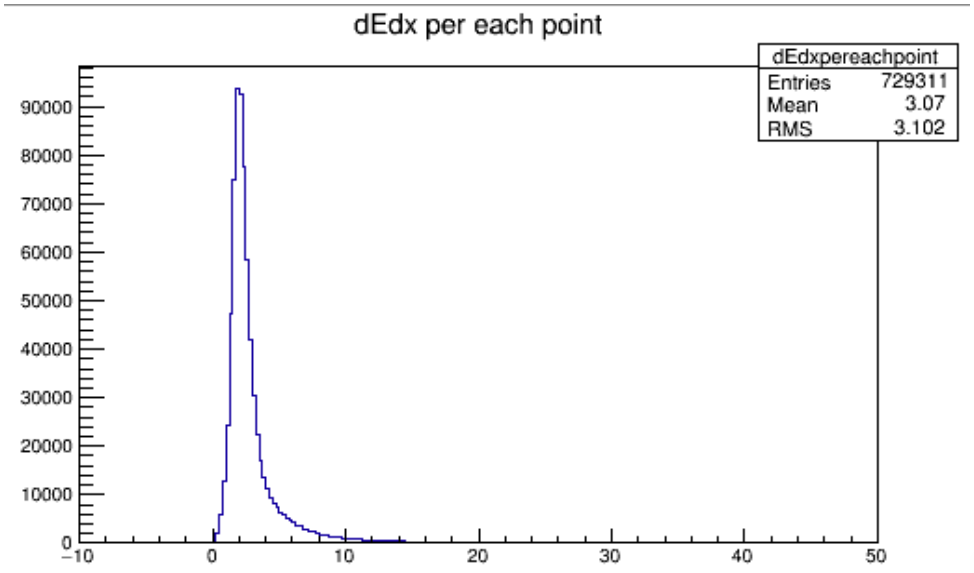
	All	With A.G. Hits	
Pi/Mu	753	753	100.0%
Proton	878	51	5.8%

From the protons, we can expect a 5.8% miss-tag rate

Calorimetry Cut

Protons ionize much more heavily than kaons
This can be used to remove proton contamination from kaon sample

First approach was to use the beamline to select protons and determine the landau distribution of its ionization:



* Run 6260

Clearly something is wrong!
Peak is almost exactly the one measured for pions (by Elena).

Due to a disconnect between the beamline and the TPC tracks.
Pion group has solved this issue with a number of cuts.

Calorimetry Cut

Beamline and TPC matching

1) Single TPC track

UpstreamTPCMultipliciryFilter.fcl (sic) and UpstreamTPCTrackFilter.fcl

Limits the number of Upstream TPC events to one, meaning only one particle has entered the TPC during this event

2) WCTrack and TPC Track Matching

WC2TPCTrackMatch.fcl and WC_TPC_TrackMatchFilter.fcl

Matches WC Tracks with TPC Tracks by extrapolating the WCTrack to the TPC face and measuring the positional / angular difference with TPC Track.

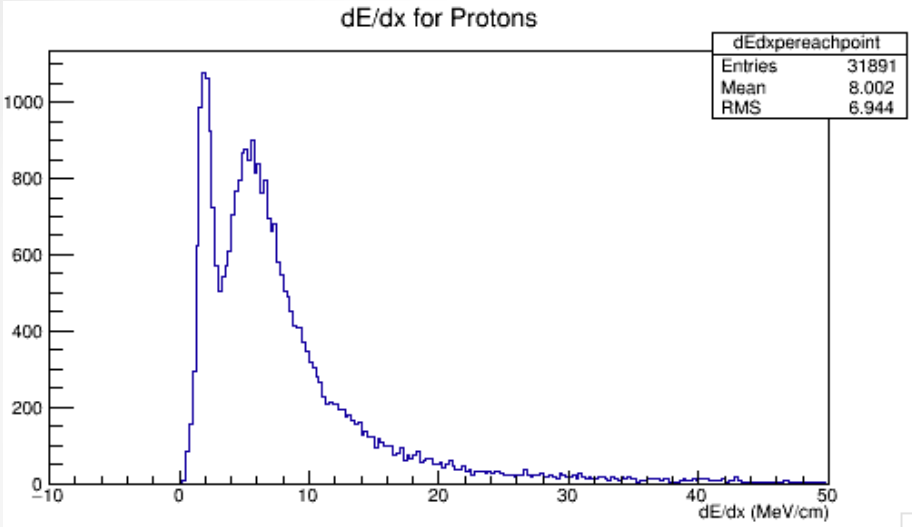
3) Primary Track Calorimetry Only

It is essential that the calorimetry information be gathered only for the primary track. In the case of the kaon, any species created in decay will contaminate the results.

Calorimetry Cut

Results on Proton Study

After applying all of these cuts and restriction on the proton sample:



Not perfect due to uncertainty in TPC/WCTrack matching and primary track filtering

MPV: 5.43 MeV/cm
Sigma: 1.36

I do not know what sigma means for a landau distribution …

With this number in hand, we can create a new cut that does several things:

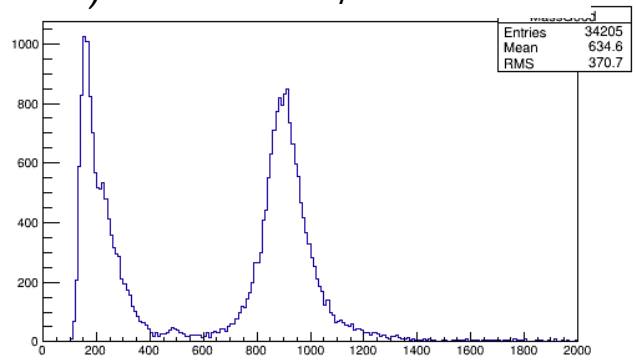
1) Creates histogram of dE/dx of the primary track of an event
2) Find MPV by taking the average of the highest bins
3) Cuts based on this value. Currently, from eyeing it, the value is 4.0 MeV/cm

This is a Preliminary study. Still have a lot of work to do:

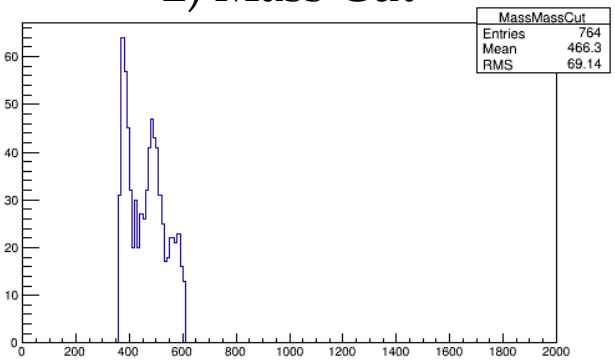
1) Calculate the MPV for the kaon
2) Better understand contamination in dEdx of protons
3) Much much more …

Reduction Table

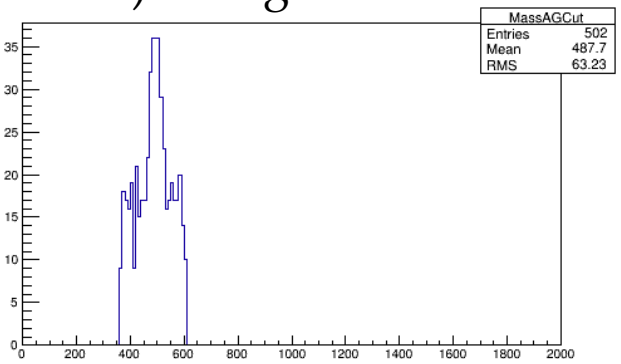
1) Good TOF/ WCTrack



2) Mass Cut



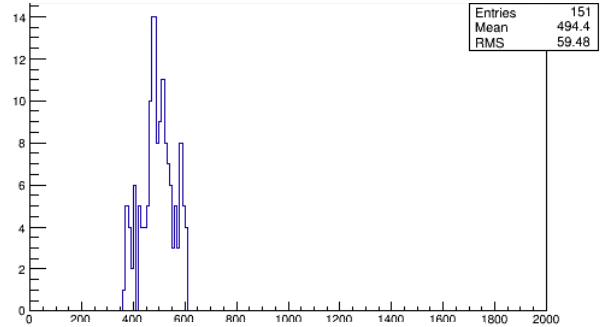
3) Aerogel Cut



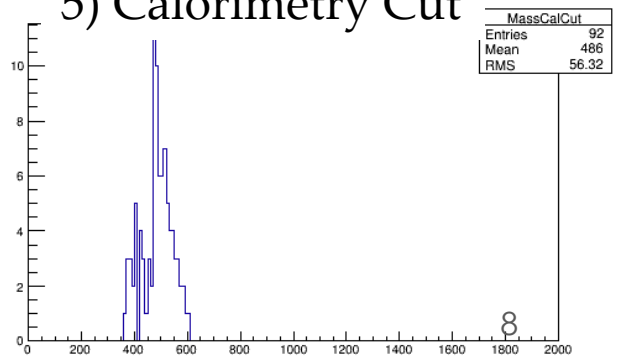
All Run I Events with Positive Bending Magnet Polarity

Cut	Remaining Events
Single TOF/WCTrack	34205
Mass Cut	764
Aerogel Cut	502
TPC Track # and Match	151
Calorimetry Cut	92

4) TPC Track # and Match

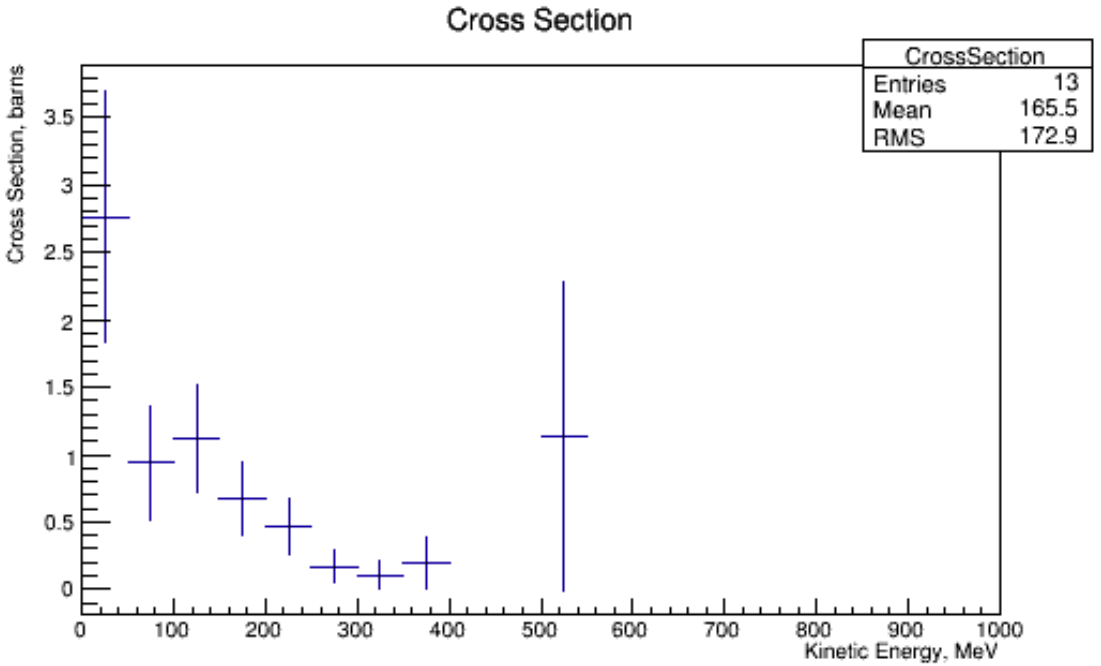


5) Calorimetry Cut



New K+ Cross Section

Using the new kaon sample of 92 Events:



Future Work:

- Beamline study to determine time required for desired statistics
- Further calorimetry studies to better understand the cut
- Exam Run II for its kaon potential
- Monte Carlo! Have not touched the Monte Carlo at all
- Much Much More